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A sustainable cyclical sea-level rise adaptation scheme for a wide green dike system

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Effective adaptation to sea-level rise is critical to protect people and their livelihoods from floods in the future. One solution to mitigate the threat of sea-level rise is to utilise the natural sedimentation in coastal wetlands as a sustainable resource to reinforce the dikes. A wide, gently sloping grass-covered dike known as a 'wide green dike' can be constructed out of the locally accreted material. However, this system of dike and wetland not only needs to provide sufficient protection against floods but also ensure enough sediment remains available for the wetland to restore itself and grow in conjunction with the uncertain sea-level rise. This study investigates the sustainability of the multifunctional use of wetlands as a resource for flood protection against sea-level rise.

This study looks at a wetland-dike system in the Ems-Dollart estuary, the Netherlands, as a case-study where pilots are being conducted by multiple parties within the Dutch high water protection program with the aim to convert local sediment and dredge spoil into clay. The objective of the pilots is that the wetland-dike system is safe enough to satisfy the Dutch national safety standard (the Ultimate Limit State). This study also incorporates the sustainability aspect of maintaining sufficient sedimentation within the wetland for future reinforcement measures (Serviceability Limit State). The failure probabilities of both limit states are evaluated to determine the safety provided by the wide green dike and its sustainability.

To this end we combine a basic sedimentation model and a probabilistic assessment of dike failure under multiple sea-level rise scenarios. By assessing both wave impact on the grass revetment and overtopping over the dike crest the optimal design for a coastal grass dike that requires the least amount of clay under these scenarios is determined and compared with the availability of sediment that can be expected from sedimentation in the wetland.